National Aeronautics and
Space Administration

Sensors

Streamlined Liquid Level Sensing Using Fiber Optics

For extraordinary accuracy when measuring liquid levels for many industrial and cryogenic applications

Innovators at NASA's Armstrong Flight Research Center have developed a highly accurate method for measuring liquid levels using optical fibers. Unlike liquid level gauges currently on the market that rely on discrete measurements to give broad approximations of liquid levels, Armstrong's innovative fiber optic method provides precise and accurate measurements. Specifically, Armstrong's novel method is capable of providing measurements at 1/4-inch intervals within a tank. This significant leap forward in precision and accuracy in liquid level sensing offers significant benefits to many industries. Originally designed by NASA to monitor a rocket's cryogenic fuel levels, this technology can be used in many medical, industrial, and pharmaceutical applications.

BENEFITS

- **Precise:** Can gauge liquid levels within a 1/4-inch
- **Simple:** Requires just one fiber optic strand and one metallic wire, as opposed to conventional measurement systems, which require many more wires
- **Safe measurement:** Is not susceptible to electromagnetic interference (EMI)
- **Robust:** Can be used in corrosive or toxic liquids without damaging the fiber or contaminating the liquid

technology solution

THE TECHNOLOGY

Armstrong has developed a robust fiber optic–based sensing technology that offers extraordinary accuracy in liquid level measurements. The sensing system uses fiber optic Bragg sensors located along a single fiber optic cable. These sensors actively discern between the liquid and gas states along a continuous fiber and can accurately pinpoint the liquid level.

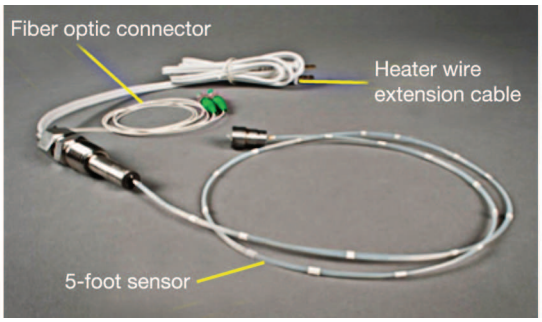
How It Works

The technology uses a resistive heater wire bundled with the optical fiber. The heater is pulsed to induce a local temperature change along the fiber, and the fiber Bragg grating data is used to monitor the subsequent cooling of the fiber. The length of fiber in the liquid cools more rapidly than the portion of the fiber in the gas above the liquid. The measurement system accurately establishes the location of this transition to within 1/4-inch.

Why It Is Better

Armstrong's liquid level sensing technology was originally developed to measure cryogenic liquid levels in rockets, and it represents a significant advancement in the state of the art in this application. Conventional methods for measuring cryogenic liquid levels rely on cryogenic diodes strategically placed along a rod or rack. The diodes are mounted in pre-selected, relatively widely spaced positions along the length of a rod; this configuration provides limited, imprecise data. Furthermore, each diode on the rod has two wires associated with it, which means a single system may require a large number of wires, making installation, connectivity, and instrumentation cumbersome.

Armstrong's novel technology provides liquid measurements with much greater precision, achieving measurements at 1/4-inch intervals. Furthermore, the streamlined system uses just two wires, which greatly simplifies installation and instrumentation. Due to its extraordinary accuracy and ease of use, Armstrong's measurement system offers important advantages for a wide range of applications beyond cryogenic liquids.



NASA photo

APPLICATIONS

The technology has several potential applications:

- Aerospace, especially liquid fuel launch vehicles and satellites
- Chemical or refinery plants to monitor the facility's fluid flow
- Industrial tanks to measure level of cryogenic or other liquids (e.g., for liquid natural gas storage and transport)
- Food and beverage manufacturing
- Pharmaceutical manufacturing
- Medical or hospital operations
- Other industries that require level measurement within large containers or for materials that are difficult to measure (e.g., cryogenic liquids)

PUBLICATIONS

Patent No: 9,074,921

More Information

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